

# **QUICK REVISION MODULE (UPSC PRELIMS 2022) GEOGRAPHY**

## **UNIVERSE AND SOLAR SYSTEM**



# THE UNIVERSE: THE VAST SPACE SURROUNDING US IS CALLED UNIVERSE. IT IS MOSTLY EMPTY SPACE.

## ORIGIN OF THE UNIVERSE

### BIG BANG THEORY OR EXPANDING UNIVERSE HYPOTHESIS

- It was given by **Edwin Hubble**.
- In the beginning, universe was a tiny ball (single atom) with **unimaginably small volume and infinite temperature and density**.
- 13.7 billion years ago, this ball exploded leading to a huge expansion. This expansion is continuing until now, at a smaller pace. **First atom** began to form within 3 minutes of Big Bang.
- Within 300,000 years of explosion, temperature dropped to 4500 K and gave rise to **atomic matter**. Universe became **transparent**.
- The expansion in universe means increase in space between the galaxies.
- An alternative theory is '**Hoyle's concept of steady state**' which considers universe to be roughly of same size at any point of time.

**The Stars:** They are the heavenly bodies like the sun that are extremely hot and have light of their own. Stars are made up of vast clouds of hydrogen gas, some helium and dust.

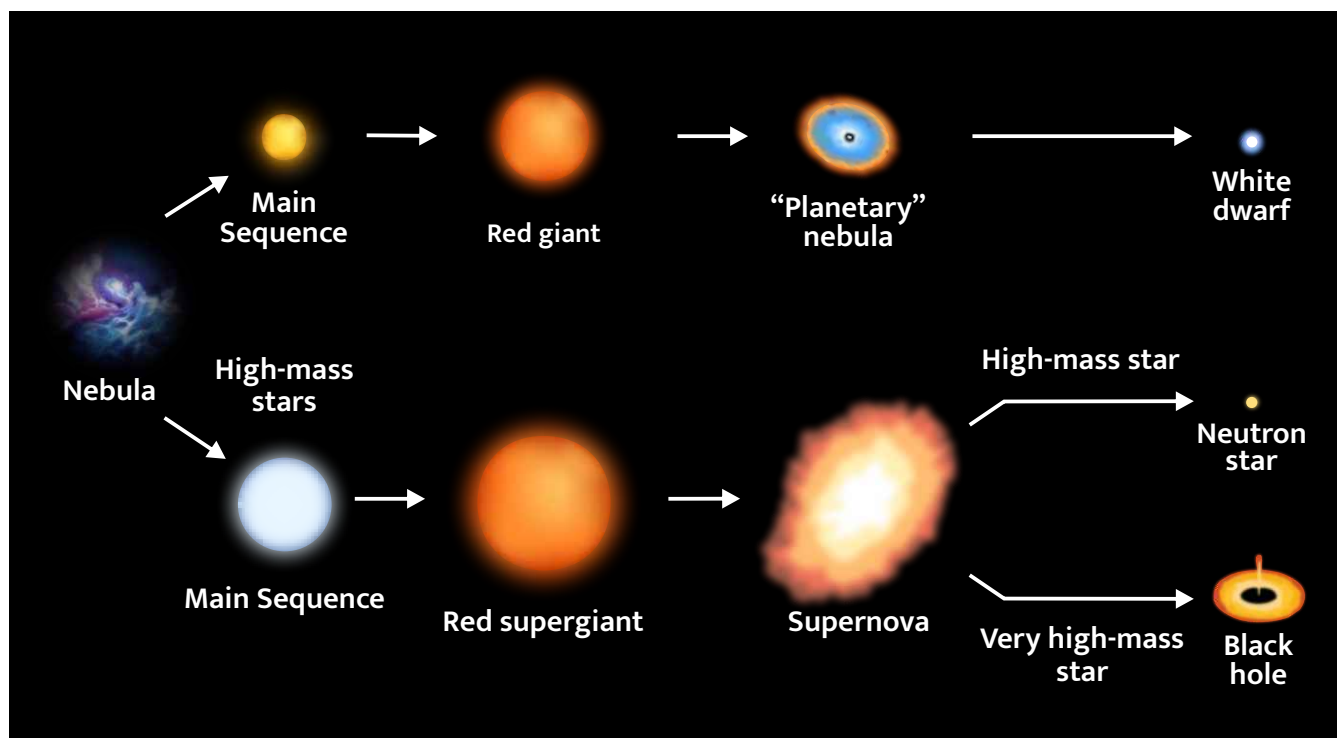
**Galaxies:** They are building blocks of the universe. Galaxy is a vast system of billions of stars, which also contains a large number of gas clouds mainly of hydrogen gas (where stars are born), and dust, isolated in space from similar system.

## NEBULAR HYPOTHESIS

- A galaxy starts to form by accumulation of Hydrogen gas in the form of a very large cloud called **Nebula**.
- This growing Nebula starts developing **localized** clumps of gas.
- These clumps continue to grow into even denser gaseous bodies, giving rise to **formation of star**.
- This event took place **5 to 6 billion years ago**.

## STELLAR EVOLUTION

### LOW AND MEDIUM-MASS STARS (INCLUDING THE SUN)



# BIRTH AND EVOLUTION OF A STAR



PROTOSTAR

In the beginning, Galaxy had just very cold ( $-1730^{\circ}\text{C}$ ), **dense and large cloud of gases** (Hydrogen and Helium). Very large gravitational pull led to the formation of a highly condensed body called Protostar. A protostar is a huge, dark, ball of gases. It does not emit light.



STAR

Further contraction of Protostar leads to collision of Hydrogen gases and increases the temperature of the protostar from  $-173^{\circ}\text{C}$  to  $10^7^{\circ}\text{C}$ . Hence, fusion reaction, where 4 Hydrogen nuclei fuse to form Helium and release tremendous amount of energy in the form of heat and light. **It makes the star shine.**



RED STAR

Fusion reaction stops in the core when its Hydrogen gets exhausted. Pressure of the core diminishes and core starts shrinking. Fusion takes place as some Hydrogen remains in the envelope/outer shell. It makes the star unstable. The star Expands and turns Red.

Sun will enter its Red giant phase in 5000 million years from now. Its expanding outer shell at the time will engulf inner planets i.e. Mercury Venus and Earth.



DWARF STAR

When mass of star  $< 1.44$  times the mass of Sun (Chandra Shekhar limit), it ends up as a white dwarf.

The Red Giant Star loses its outer envelop and core shrinks into an extremely dense ball of matter due to gravitation. This leads to another set of fusion reaction where Helium fuses to form carbon. The fuel gets completely exhausted and the core shrinks under its own weight and becomes a white dwarf.



## SUPERNOVA

When mass of star  $> 1.44$  times that of Sun, there remains enough Helium in the core for fusion reaction. The outer envelope explodes causing Supernova Explosion.

When mass of the star is between 1.44 to 3 times that of Sun, it becomes a Neutron Star

When mass of the star is bigger than 3 times that of Sun, it becomes a Black hole.

## THE SOLAR SYSTEM:

Sun is a ball of hot gases, mainly Hydrogen.

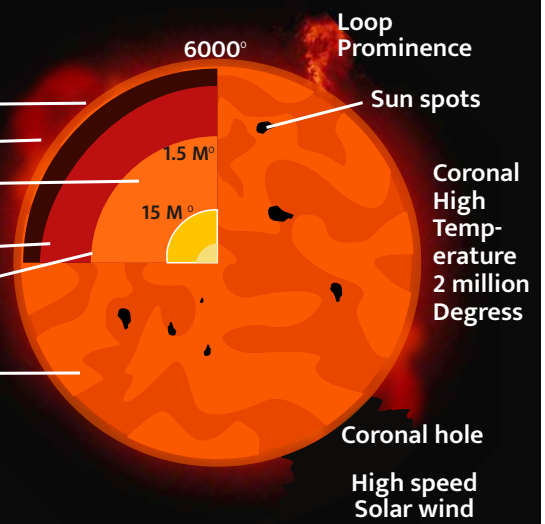
Shining surface of the Sun is called Photosphere.

The outer layer of the sun's atmosphere is made up of thin hot gases is called Corona.

Corona is visible only during full eclipse.

### THE SUN

Chromosphere  
Spicules  
Radiative Zone  
Convection Zone  
Core  
Photosphere

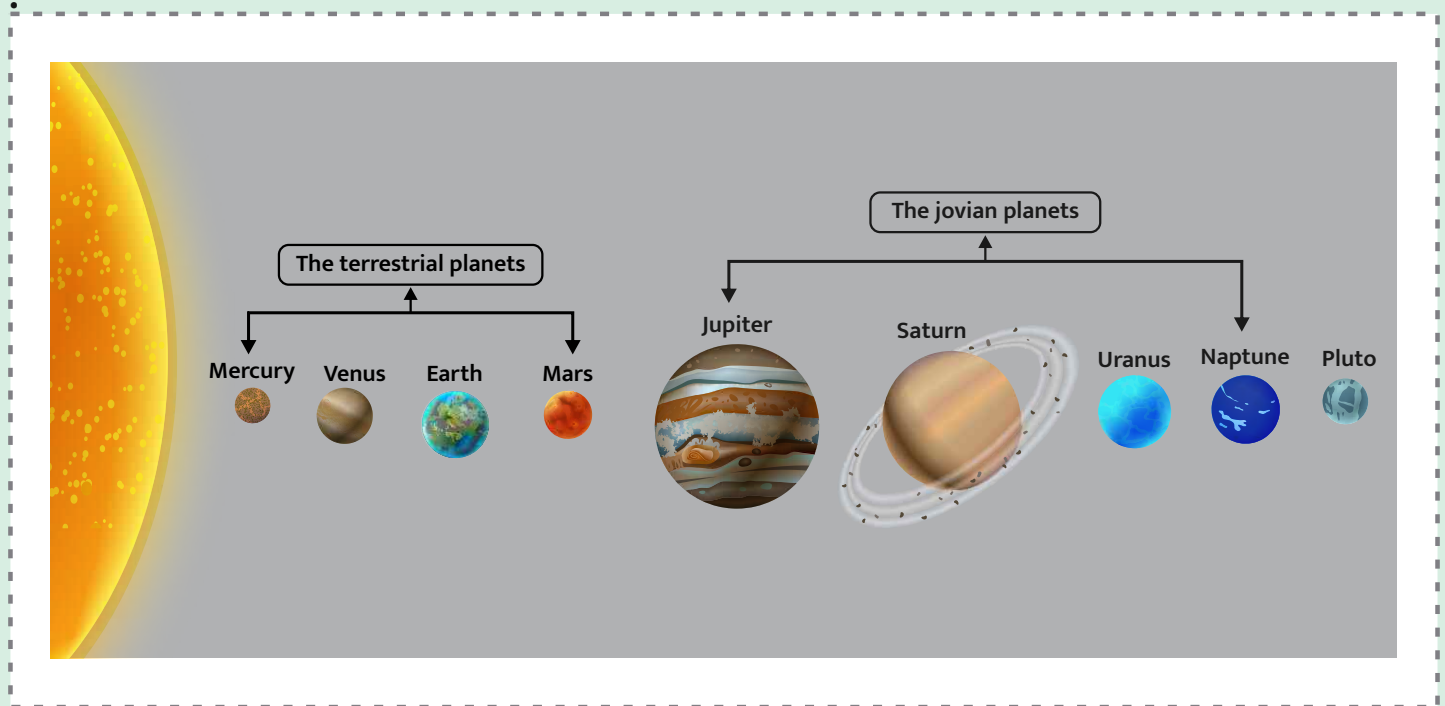


## GOLDILOCKS ZONE:

A habitable zone, also called a Goldilocks zone, is the region around a star where orbiting planets similar to the Earth can support liquid water. It is neither too hot, nor too cold.

# PLANETS

Planets are solid heavenly bodies which revolve round a star (e.g. the sun) in closed elliptical paths. A planet is made of rock and metal. It has no light of its own. A planet shines because it reflects the light of the sun. The planets move round the sun from west to east, so the relative positions of the planets keep changing day by day. There are 8 major planets including the earth.



## CASE OF PLUTO:

As per International Astronomical Unit, three given characteristics are required to qualify as a planet:

- 1 The celestial body has to be in orbit of the Sun
- 2 It must have sufficient mass to assume hydrostatic equilibrium (i.e. a nearly round shape), and
- 3 It must have 'cleared the neighbourhood' around its orbit i.e. it must become the dominant gravitational body in their orbit. Pluto lacks the third characteristic. That's why it is not a planet anymore and has been categorized as a Dwarf Planet.



# TWO GROUPS OF PLANETS: TERRESTRIAL VS JOVIAN



## TERRESTRIAL PLANETS (EARTH LIKE)

- Four innermost planets i.e. Mercury, Venus, Earth, and Mars
- They have a compact, rocky surface like Earth's terra firma.
- None of the terrestrial planets have rings, although Earth does have belts of trapped radiation.
- Among the terrestrials, only Earth has a substantial planetary magnetic field. Mars and the Earth's moon have localized regional magnetic fields at different places across their surfaces, but no global field.
- Of the terrestrial planets, Venus, Earth, and Mars have significant atmospheres.
- Mercury lacks an atmosphere. Even though most of its surface is very hot, there is strong evidence that water ice exists in locations near its north and south poles which are kept permanently shaded by crater walls.
- Venus' atmosphere of carbon dioxide is dense, hot, and permanently cloudy, making the planet's surface invisible.
- Mars' atmosphere, also carbon dioxide, is much thinner than Earth's. Mars has polar caps of carbon dioxide ice and water ice.



## JOVIAN PLANETS (JUPITER LIKE)

- Includes Jupiter, Saturn, Uranus, and Neptune are known as the Jovian (Jupiter-like) planets, because they are all gigantic compared with Earth, and they have a gaseous nature like Jupiter's -- mostly hydrogen, with some helium and trace gases and ices.
- Also referred to as the "gas giants".
- All of them have significant planetary magnetic fields, rings, and lots of satellites.
- Jupiter is more massive than all the other planets combined. It emits electromagnetic energy from charged atomic particles spiraling through its strong magnetic field.
- Saturn, the farthest planet easily visible to the unaided eye, is known for its extensive, complex system of rings. Its moon Titan is the second largest moon after Ganymede (Jupiter's moon).
- Among four Galilean satellites of Jupiter:
  - ▶ Io is the most volcanically active body in the solar system, due to heat resulting from tidal forces.
  - ▶ Europa is covered with an extremely smooth shell of water ice. There is probably an ocean of liquid water below the shell.
  - ▶ Ganymede has mountains, valleys, craters, and cooled lava flows. Its ancient surface resembles Earth's moon, and it is also suspected of having a sub-surface ocean.
  - ▶ Callisto, the outermost Galilean moon, is pocked all over with impact craters, indicating that its surface has changed little since the early days of its formation.

- Together, they have just 3 moons (1 of Earth and 2 of Mars).

- Saturn, Uranus and Neptune all have rings made up of myriad particles of ice ranging in size from dust and sand to boulders.

## SATELLITES:

A satellite (or moon) is a solid heavenly body that revolves round a planet. Except Mercury and Venus all other planets of solar system have satellites. The satellites have no light of their own. They shine because they reflect the light of the sun.

- Jupiter has the largest number of Moons. It also has the biggest moon of the solar system, Ganymede.
- Saturn's moon 'Titan' has its own atmosphere.

### ABOUT EARTH'S MOON

- It is a natural satellite of Earth. It revolves around the Earth in a definite regular path.
- Gravitational attraction of the earth holds the moon into its orbit.
- It is about 1/4th size of the Earth in diameter and 1/8th in weight.
- Moon does not have air or water. Its surface is covered with hard and loose dirt, craters and mountains.
- Days are extremely hot and nights are very cold on moon.

## THEORIES OF FORMATION OF MOON:

### 1. DARWIN:

Both earth and moon formed a single rapidly rotating body. The whole mass became dumb-bell shaped and eventually broke.

### 2. MATERIALFORMING

The moon was separated from what we have at present the depression occupied by Pacific ocean.

### 3. GIANT IMPACT OR THE BIG SPLAT:

A body of the size of one to three times that of Mars collided into the earth shortly after the earth was formed. It blasted a large part of earth into the space. The blasted portion started revolving around the earth and eventually formed into the present moon after 4.4 million years ago. Most accepted theory.



# OTHER OBJECTS IN THE SKY:

## ASTEROIDS



- Asteroids are a belt of debris composed of rock and metals, which somehow failed to assemble into a planet and keep revolving between the orbits of Mars and Jupiter.
- There are as many as 100,000 asteroids. The biggest asteroid called 'Ceres' has a diameter of about 800 km whereas the smallest asteroid is of size of a pebble.
- Asteroids can collide with earth. It is believed that the extinction of dinosaur was due to such a collision. The Lonar Lake in Maharashtra is a filled up crater formed after an asteroid collision.

## COMETS



- They are celestial objects formed of ice and dust. They were formed very early from the same gas clouds from which other members of the solar system are formed.
- They orbit the Sun. When their normal path gets disturbed, they start moving towards the sun. As the comet approaches Sun, the ice sublimates into gas and form along with the entrained dust particle, a bright outflowing atmosphere around the comet nucleus called Coma. The comet may also form two tails, one of ionized molecules and radicals and other of dust.
- The tails of the comet always point away from the Sun. The study of the tails of the comet has shown presence of Carbon, Hydrogen, Nitrogen and Oxygen in it.
- Comets do not last forever. Whenever they come close to sun, their gases get over and ultimately only dust particles remain.

## METEORS



- They are small celestial bodies (may include dust particles of a comet, or a piece of broken asteroid) which enter into the earth's atmosphere and burns as a bright streak of light due to heat produced by the friction of its impact with the atmosphere.
- They are also called shooting stars.
- If a Meteor is big enough and does not gets burnt up completely, and lands on earth (like stones from sky), it is called Meteorite.
- It should be noted that the number of meteorites on moon's surface is much larger than that on earth because moon does not have an atmosphere to burn the meteor.
- Study of meteorites can reveal the nature of materials of which the solar system is composed of.

# THE EARTH'S MOVEMENT:

The Earth, as the rest of the planets of the Solar System, rotates on its and (rotation movement) and around the Sun (Orbit movement). These two movements are responsible for phenomena such as day and night and the sequence of the seasons.

## ORBIT

The Earth takes 365 days, 5 hours and 48 minutes to complete a burn around the Sun. As the Sun Varies its position relation as the Sun. The seasons appear and thee variation of the days and nights.

**23° 5'**

Is the angle between the Earth's axis and the Sun.

**JUNE 21<sup>st</sup>**

Summer solstice in the Northern hemisphere. It is the longest day of the year.

**SEPTEMBER 21<sup>st</sup>**

Autumnal equinox in the Northern Hemisphere. Day and night have the same amount of hours.

**MARCH 21<sup>st</sup>**

Spring equinox in the Northern hemisphere. Day and nigh hours are the same.

## LEAP YEARS

Every four years February has 29 days instead of 28 they are the leap years.

**DECEMBER 21<sup>st</sup>**

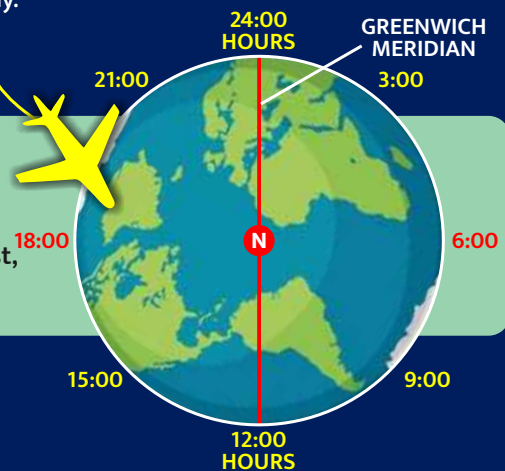
Winter solstice in the Northern hemisphere. It is the shortest day of the year.

## JET LAG

Long distance trips on an airplane cause same well known disorders such as jet lag. Since they alter the habitual schedules of the body.

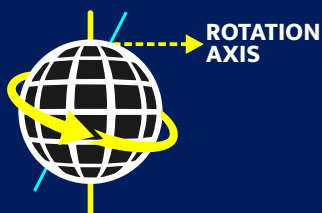
## TIME ZONES

The Earth is divided in twenty four areas or time zones, each with a different time, with Greenwich Meridian as a central axis. As you areas a meridian to the East, an hour is added, and when you cross it to the West, an hour is substracted.



## ROTATION

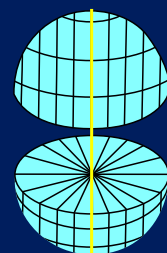
Rotation is thee turn that the earth does on its axis every day. It is the responsible movement for the succession of days and nights, of the flattening of the poles, the marine currents and the different time zones.



## HEMISPHERES

The Earth is divided into two halves; the northern hemisphere and southern hemisphere. Equator is the imaginary line between them. When it is summer is the north, south is winter and vice versa.

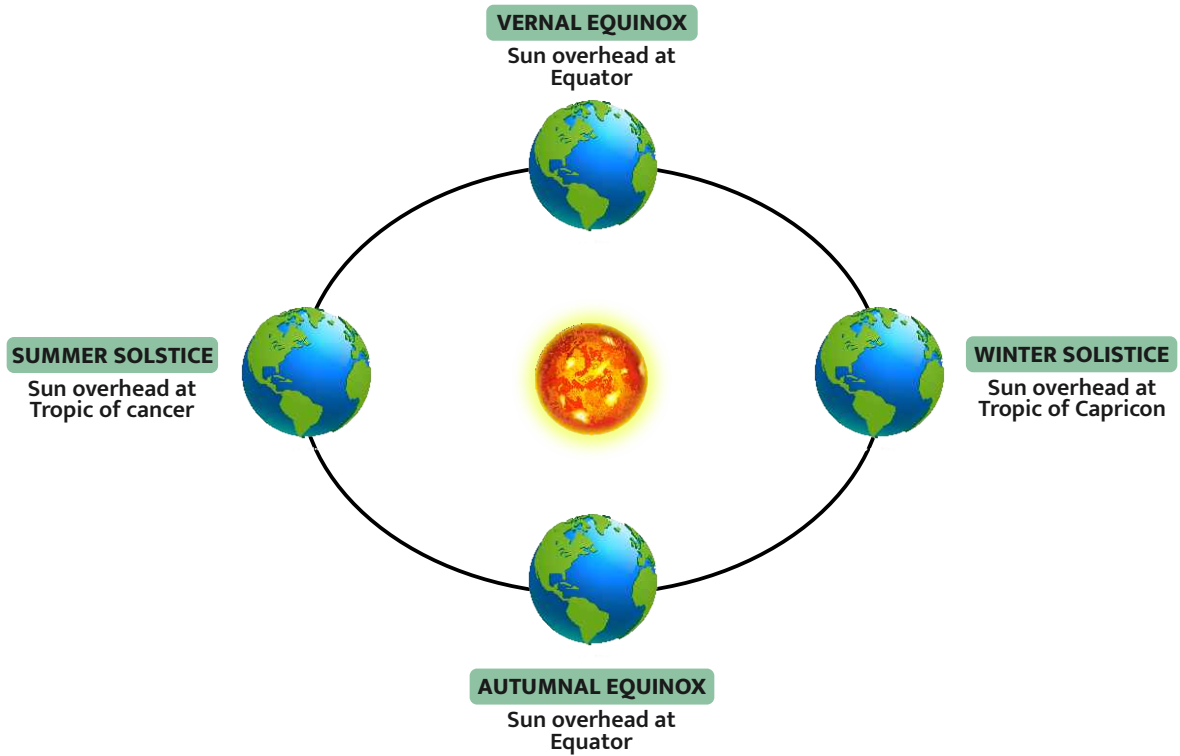
## NORTHERN HEMISPHERE



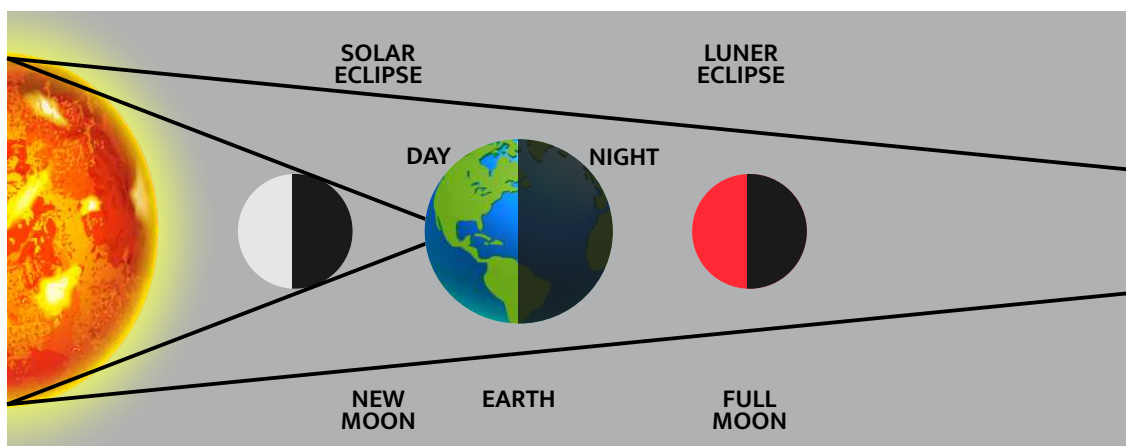
EQUADOR

## SOUTHERN HEMISPHERE

## POSITION OF SUN OVERHEAD



## ECLIPSE



## ECLIPSE

